

FINAL TECHNICAL REPORT FOR
October 1, 1986 - June 30, 1990

TO: National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

REFERENCE: NASA Grant No.: NAG 5-853

ORGANIZATION: Center for Climatic Research
Department of Geography
University of Delaware
Newark, Delaware 19716

PROJECT TITLE: A High-Resolution Climatology of the
Terrestrial Seasonal Water Cycle

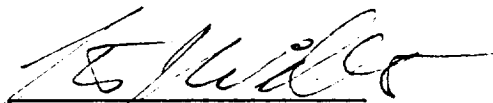
P.I.: Dr. Cort J. Willmott

DATE: August 14, 1990

DURATION: Four Years: October 1, 1986 - June 30, 1990

SIGNATURE:

Principal Investigator,



Cort J. Willmott

(NASA-CR-193702) A HIGH-RESOLUTION
CLIMATOLOGY OF THE TERRESTRIAL
SEASONAL WATER CYCLE Final
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Over the course of NASA grant NAG 5-853 (October 1, 1986 - June 30, 1990), a number of findings were reported in the climatological literature or at professional gatherings (see the attached list of 'Grant Supported Publications, Papers and Theses'). There were approximately 1) 12 papers (several were invited) presented at conferences or before University audiences, 2) two theses (one MS and one Ph.D.) completed, 3) one proceedings paper published, and 4) three journal articles written (two have been published and one is under review). Four more journal articles are in preparation. It is anticipated that the four manuscripts in preparation will be submitted before the end of the year.

Our principal contributions have been the compilation and analysis of high-resolution (gridded at 0.5° of latitude by 0.5° of longitude) monthly-average global air temperature (T) and precipitation (P) fields (Legates and Willmott, 1990a; 1990b). These data bases have allowed us to ascertain certain systematic errors in GCM-simulated T and P fields (Legates and Willmott, 1991; Willmott and Legates, 1991) as well as errors within existing empirically-based climatologies. The high-frequency, spatial variability in the P field has been of special interest, and our integrations of this field have yielded one of the highest estimates of average global precipitation (\bar{P}) in the literature (Willmott and Legates, 1990). It also has suggested to us that \bar{P} may have risen over the course of the twentieth century. Our data bases are encoded and available by contacting Professor Willmott.

In order to obtain better estimates of soil moisture, we began working (later in the grant) on spatially variable estimates of total and total-available soil water holding capacities (w_t and w_a) (Patterson, 1990; Patterson and Willmott, 1991; Willmott and Patterson, 1991). Account has been taken of soil type and texture, organic matter and rooting depth, as well as of other variables. Preliminary water-balance calculations show several important differences in the global soil moisture and evapotranspiration fields when w_a is held constant at 150mm (common practice) and our spatially-variable w_a is used. Work is ongoing (i.e., we are attempting to develop a better vegetation parameterization using microwave satellite data and our own vegetation data set (Willmott and Klink, 1986)) and we hope to produce high-resolution monthly average fields of soil moisture, evapotranspiration and so on. Our soil parameterization is encoded and available at a $0.5^\circ \times 0.5^\circ$ resolution. Once again, Professor Willmott should be contacted.

In addition to the research contributions briefly outlined above and in the 'Grant Supported Publications, Papers and Theses' list, this grant supported much of the Master's-level education of Krista Patterson and the Ph.D.-level education of David Legates. These talented students have gone on and are making large-scale climatological contributions of their own. Ms. Patterson recently began working (under P. C. D. Milly) at Princeton's Geophysical Fluid Dynamics Laboratory (GFDL) on the ground hydrology of the GFDL climate models. Dr. Legates has become an Assistant Professor at the University of Oklahoma where he has published a number of papers on large-scale precipitation. He also has been involved in a joint Russian/American climate data exchange program.

Grant Supported Publications, Papers and Theses

- Klink, K. M. and K. Patterson, 1988. Global Distribution of Climatically Important Soil Hydraulic Properties. Paper presented at the annual meeting of the Association of American Geographers in Phoenix, Arizona.
- Klink, K. M., Willmott, C. J., Legates, D. R., Robeson, S. M., 1989. A Critical Review of Hypothesis Testing. Paper presented at the annual meeting of the Association of American Geographers in Baltimore, Maryland. March.
- Legates, D. R., 1987. A Climatology of Global Precipitation. Paper presented at the annual meeting of the Association of American Geographers in Portland, Oregon.
- Legates, D. R., 1988. A Climatology of Global Precipitation. Newark, DE: University of Delaware (Ph.D. dissertation).
- Legates, D. R., Willmott, C. J. and Rowe, C. M., 1989. WIMP: The Water-Budget Interactive Modeling Program. Paper presented at the annual meeting of the Association of American Geographers in Baltimore, Maryland. March.
- Legates, D. R. and C. J. Willmott, 1990a. Mean Seasonal and Spatial Variability in Gauge-Corrected Global Precipitation. International Journal of Climatology, 10:111-127.
- Legates, D. R. and C. J. Willmott, 1990b. Mean Seasonal and Spatial Variability in Global Surface Air Temperature. Theoretical and Applied Climatology, 41:11-21.
- Legates, D. R. and C. J. Willmott, 1991. A Comparison of GCM-Simulated and Observed Mean January and July Precipitation Fields. Journal of Climate (in preparation).
- Patterson, K., 1990. Global Distributions of Total and Total-Available Soil Water Holding Capacities. Newark, DE: University of Delaware, Department of Geography. MS thesis.
- Patterson, K. and C. J. Willmott, 1989. Global Distribution of Soil Field Capacity. Paper presented at the annual meeting of the Association of American Geographers, Baltimore, Maryland.
- Patterson, K. and C. J. Willmott, 1991. Global Distribution of Soil Total-Available Water Capacity. Global Biogeochemical Cycles (in preparation).
- Willmott, C. J., 1988a. Estimating Global Climatic Water Balances from Archival Data. Paper presented at the Second Annual Penn State University Earth System Science Center Workshop entitled "The Global Water Cycle: Past, Present and Future" in State College, Pennsylvania (July 25-29).
- Willmott, C. J., 1988b. Estimating Terrestrial Variables for Use in Global Climate Studies. Lecture presented in the Geography Department at the University of Maryland, College Park, Maryland (October 28).

- Willmott, C. J., 1988c. Global Terrestrial Seasonal Water. Paper presented at the Interdisciplinary Science Land Surface Climatology Third Meeting in Las Cruces, New Mexico (Nov. 16-18).
- Willmott, C. J., 1990a. Estimating the Global Water Balance from Traditional Data. Invited lecture at San Diego State University on Feb. 22, 1990.
- Willmott, C. J., 1990b. Estimating Components of the Land-surface Water Cycle from Traditional Data. Invited lecture given at Princeton University's Geophysical Fluid Dynamics Laboratory. March 22, 1990.
- Willmott, C. J. and J. E. Burt, 1986. A High-Resolution Climatology of the Terrestrial Seasonal Water Cycle. First progress report presented at the NASA IDS/LSC working group meeting in Nogales, Arizona.
- *Willmott, C. J. and K. M. Klink, 1986. A Representation of the Terrestrial Biosphere for Use in Global Climate Studies. Proceedings of the ISLSCP Conference, Rome Italy, (ESA SP-248), 109-112.
- Willmott, C. J., D. R. Legates and J. E. Burt, 1987. A High-Resolution Climatology of the Terrestrial Seasonal Water Cycle. Second progress report presented at the NASA IDS/LSC working group meeting in Tempe, Arizona.
- Willmott, C. J. and D. R. Legates, 1990. Rising Estimates of Average Global Precipitation. Climatic Change (submitted).
- Willmott, C. J. and D. R. Legates, 1991. A Comparison of GCM-Simulated and Observed Mean January and July Air Temperature Fields. International Journal of Climatology (in preparation).
- Willmott, C. J. and K. Patterson, 1991. Influence of a Spatially Variable Soil Available Water Capacity on Soil Moisture and Evapotranspiration. International Journal of Climatology (in preparation).

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